Simulation Return on Investment

Analyzing the benefits of acquiring a simulator for training purposes

Overview

Over the last 20 years, GlobalSim, Inc. has provided training simulators to dozens of organizations throughout the world. We manufacturer, sell, and support simulators to organizations in the military, port, and construction markets.

In some industries, simulation is a foregone conclusion. The merits and benefits are well known and training in a simulator is compulsory. In the world of aviation, it is fully expected that pilots will train on a simulator before being licensed. Likewise, simulators have been used by the military for decades to train soldiers and logistics personnel. In other industries, simulation is not compulsory but still used regularly by organization to provide operator training. This generally the case for industries served by GlobalSim. Simulators are commonly used to train operators when the costs are high and a training failure has the potential to cause a catastrophic accident that could result in loss of human life or a significant financial loss. There are many significant advantages to simulation which are not always obvious and considered by organization that haven't used simulators in the past. These include:

- **Reduce Training Time & Expenses**
- **Opportunity Costs**
- **Increase the Efficiency of Novice Operators**
- **Reduce Accidents**
- **Screen Crane Operators**
- **Monitor & Test Objectively**

The metrics and evidence in this paper are constructed from data provided by real training institutes. Much of the data has been provided by the OCHA training center in Antwerp, Belgium – one of the premier port crane training facilities in Europe. Though the data and calculations will need to be adjusted to suit the specific needs of an organization, the principals and formulas can help any organization decide on whether to invest in simulation.

Reduce Training Time / Expense

One of the principle reasons cited by many training centers in favor of simulation is the reduction of training time and training expenses. When comparing simulation training to alternatives, there are costs that can be quantified and evaluated. In most cases, the alternatives to simulation training are to train on the real equipment or to send the student off-site for training.

A brief evaluation of these alternatives is merited. Please note, this section will primarily focus on quantifiable costs. Soft costs will be covered detail in other sections.

Training on real equipment

Evaluating the cost of traditional crane training must include the cost of running the equipment, the cost of personnel, and the opportunity cost of not having the equipment available for revenue producing activity.

Approximately half of the cost of operating an STS crane is the cost of personnel.[1] For training, the labor rate for both instructor and the students should be considered. This becomes particularly important if there is one instructor per student operator for the real equipment. With crane simulators, there may be one instructor for multiple students.

Consider the following costs for operating a USD $5 million ship-to-shore (STS) port crane each year.[2]

Labor cost at an average of 12 hour days = USD $630,000
Consumables = USD $50,000 to $100,000
Depreciation = USD $250,000 (with 6% interest – USD $407,500)
Energy = USD $54,000 (at 30 moves/hour and USD $0.2 per kWh)

Other items also add to the cost of crane operation such as lighting for night operation, brake or motor wear due to improper or abusive operating methods, etc.

Training Off-site

For some organizations, the risk is too high to have an untrained operator learn on the job. Additionally, there may seldom be a spare crane available for training. Training off-site may seem like a reasonable solution for some organizations, however it can be more expensive than training on the real crane. An Operations Manager for a small port in Peru said he currently spends USD $100,000 to send 6 people for 6 weeks of crane training in another country. This is more than USD $16,000 per person (which includes the training costs, as well as the travel, accommodations, and salary). These factors may vary depending upon geography and other factors, but any reasonable amount of research can yield similar numbers. A well-equipped training center in Europe charges over 1500 Euro per day for crane training. And the training could take 10 days.

Training on your own simulator

The cost savings of training on simulator verses the real equipment are two-fold. First, the cost of operating a simulator is much less than the real equipment. Second, training time is reduced. By using simulation, one port claimed their total crane training time dropped 20%. The training time on the real cranes dropped 50%.[3] A simulator will not eliminate all training on a real crane. But the cost savings come from both reducing the training time on the real crane and having higher productivity on the real crane sooner.

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[1] Port Technology International, issue 17. Gerhard Fischer & Laurens Franken, Siemens MC Cranes
[2] Ibid
[3] OCHA – Training organization for the Port of Antwerp

Analysis

A sophisticate ROI analysis that gives an accurate assessment is difficult. It includes many factors. Not all information may be available. For this assessment, the following variables are considered and a reasonable value is assumed for each variable. Small changes in each value could have a large influence on the result.

Variables

$ 220	Crane cost per hour
$ 70	Instructor labor per hour (including benefits)
$ 40	Student labor per hour (including benefits)
	Travel costs
$ 1,500	Airfare (round-trip)
$ 130	Lodging per day (class days plus two)
$ 120	Meals per day (class days plus two)
$ 70	Car rental/taxi per day (class days plus two)
$ 1,600	Off-site training class cost per day
10	Training days per student
12	Travel days - class days plus two
$ 1	Cost of crane accidents per year
5%	Percent avoided through better training
$ 1	Crane maintenance costs per year
5%	Percent avoided through better operation
$ 1	Crane energy costs per year
5%	Percent avoided through better operation
$ 1	Profit per TEU times annual crane operator TEU moves
5%	Percent improvement through better training

A calculation worksheet was created using the above values. By changing the values in the yellow boxes below, one can get an idea of the relative costs of training. The results will depend primarily on the number of students and the cost of the simulator. Generally, the more expensive the simulator is, the higher fidelity and closer it feels like the real equipment. The highest quality simulators provide a truly immersive training experience. The objective is the provide appropriate training value for the cost of the simulator. In this case, the decision requires balancing the desire for realism and the budget available.

Calculations

Annual basis

Edit the value in the yellow boxes

		Real Crane	Off-site	Simulator
Simulator purchase price		NA	NA	$ 125,000
Students trained per year	6	6	6	6
Students per instructor		1	NA	2
Hard costs				
Crane operation		$ 105,600	NA	NA
Instructor labor		$ 31,200	NA	$ 15,600
Student labor		$ 19,200	$ 19,200	$ 19,200
Off-site class		NA	$ 96,000	NA
Travel costs		NA	$ 24,540	NA
Soft costs				
Accident avoidance		NA	NA	$ (0.05)
Crane operation cost reduction		NA	NA	$ (0.10)
Improved productivity		NA	NA	$ (0.05)
Total costs		$ 156,000	$ 139,740	$ 34,800
Years to recoup investment		**NA**	**NA**	**1.03**
(Simulator price / (Real crane training cost - simulator training cost))				

In the generic example shown in the above table, an organization that trains 6 students per year (10 days training each) will spend upwards of USD $156,000 on training (principally on operating costs of the crane itself, along with student and instructor labor). An organization that chooses to outsource crane training will theoretically save, but still pay approximately USD $139,000, principally on costs for classes and travel/accommodations. Meanwhile, the same organization, if it were to invest in a modest simulator, would spend approximately $35,000/year on training costs. One consideration often overlooked is the student/teacher ratio on real equipment is typically 1:1, whereas on a simulator it can be 2:1 or even 4:1 (assuming an organization has multiple simulators). By reducing the 1:1 ratio during the early training sessions, organizations can save considerably on labor costs.

Many training centers can streamline their training curriculum and reduce the overall training days by using a simulator early in the training process. Operators become familiar with the controls and can proceed through curriculum more quickly without the fear of failure. Ultimately the learning curve is

faster and overall training time will decrease by a factor of 10-20%, ultimately saving the organization on training costs.[4]

In addition to considering costs, some training sites can generate revenue by training students from outside the organization.

Opportunity Costs

Opportunity cost is one of the primary reasons terminal operators do not use real cranes for "on-the-job" training. A port crane costs millions of dollars. The crane's purpose is to generate revenue by transferring cargo as fast as possible between the dock and the ship. The time for ship turn-around in a port is a major consideration for shipping lines. They want the cargo transferred as efficiently as possible so they can travel to the next port. If terminals are slow in transferring cargo, they risk losing business in addition to spending money on slow transfers.

If a crane is tied up in training, it is not generating revenue. Novice crane operator are typically not very fast (terminal operators measure container moves per hour to assess productivity). From these productivity measurements, specific profits or losses can be calculated. For example, if the moves per hour were to increase 5%, the resulting profit could be calculated. On the other hand, if the efficiency were to decline, the loss in profits could be calculated. Even if there is idle time on a crane, there are still high costs to crane operation. These calculations can show the cost of using a crane for training. They can also show the increased profit by having faster crane operators.

Increase the Efficiency of Novice Operators

Most novice crane operators will slowly become more efficient over time, however during the first 90 days a newly minted crane operator is least productive. Organizations that invest in a simulation may have an advantage as their crane operators can experience rigorous scenarios and exercises on a simulator that would be impractical to do on real equipment. A 5%-10% increase in operator efficiency (as measured by moves-per-hour) can translate to thousands of dollars of cost savings.

One big advantage that a simulator brings to an organization is the ability to offer remedial and refresher training. If a crane operator experiences an accident or has need to enhance his/her skills, training on a simulator is a far superior solution that can help re-instill confidence in the operator. One training organization in Le Havre, France[5] uses their simulator to train each year to experienced operators on difficult and unexpected situations (i.e. unexpected cell phone ringing). Organizations can set up scenarios to represent difficult environments and scenarios to test even the savviest and most experience crane operators.

[4] OCHA Training Center in Antwerp, Belgium; MEA training center in Montreal, Quebec, Canada
[5] GMP Training Center, Le Havre, France

Reduce Accidents

Practice Emergency Operations

An obvious reason for training is to avoid accidents. Skilled operators have learned to operate quickly and safely. A fast crane operator could ultimately cost the terminal operator because bad habits cause unnecessary wear on the crane and increase the chance of accidents. Safety officers can provide the annual costs of accidents at a terminal. They may even have records that specify crane accidents due to operator error. The accidents can range from equipment damage to cargo damage. One company's training center calculated the millions of dollars of damage to equipment over ten years. By preventing just five percent of the accidents, they could have paid for multiple simulators. There is no danger or damage in having a simulated accident. Students can practice uncommon or dangerous operations multiple times without fear of expensive errors. Plus, an instructor can provide after action evaluation to help all the student's benefit from one student's error.

Accidents that harm personnel can be even more expensive. In addition to direct costs, there are indirect costs such as lower moral, lost labor, insurance premiums, etc. A novice is more likely to have an accident. Practicing on a simulator can improve the student's skill and confidence in the early part of training. They become safer crane operators in addition to being faster.

Screen Crane Operators

Another significant advantage and opportunity that a simulator affords a training center is the ability to screen (or weed out) potential operators. Many organizations will hire (or promote) individuals based on their self-promoted experience (i.e. resume, job history) or their seniority. In many cases, an organization will immediately invest in training that may take days or weeks. By utilizing a crane simulator, an organization can (sometimes within minutes) detect a candidate's real ability to operate a piece of equipment. An instructor or administrator can easily develop a scenario to test a candidate thoroughly on multiple different actions. Organizations can save time, money, and trouble by not advancing the career of individuals who don't measure up when evaluated in the simulator.

Monitor / Test all students objectively

In a training and testing environment it becomes difficult to avoid biases and favoritism. Rater bias is a common problem as instructors may be consciously or sub-consciously favoring students on factors unrelated to ability (i.e. friendships, personality types, etc.). A simulator helps prevent this rater bias by providing a built-in database and monitoring system that will measure all students equally and objectively. Scores and statistics showing collisions (minor, major, and fatal), moves-per-hour, optimized paths, and much more are already built into the simulator system.

Summary

There are multiple points to consider when evaluating simulation as a part of a curriculum to train crane operators. While not every organization may have the ability, or need to acquire a simulator, there is much evidence from a quantitative and qualitative perspective to suggest that a simulator is a worthwhile investment to an organization, particularly when training operators is a consistent and

ongoing occurrence.

Perhaps the best evidence we can provide is our own list of clients who continually invest in simulators as an effective training tool for their own organization. Below is just a partial list of our clients, many of whom are happy to welcome guests or share their experiences using crane simulators:

- **OCHA (Port of Antwerp, Belgium)** Straddle Carrier and Crane Training System. Configured with a Straddle Carrier model, Ship-to-Shore Container Gantry Crane model, and a Mobile-Jib Portal Harbour Crane model

- **Georgia Port Authority (Savannah, Georgia, USA)** – Full Mission Crane Training System configured with Ship-to-Shore crane, RTG Crane, etc.

- **Montreal Employers Association (Montreal, Quebec, Canada) –** Full Mission Crane Training Simulator featuring multiple crane models (including STS, RTG, Ship Pedestal). Two K-Sim Essential crane simulators featuring multiple models.

- **Pacific Maritime Association (Oakland, CA) –** Full Mission Crane Training system featuring multiple models (STS, RTG, Mobile Harbour, Ship Pedestal) configured in a portable trailer unit.

- **Thailand Port Authority** –Full Mission Crane Training System. Configured with a Ship-to-Shore Container Gantry Crane model and RTG Crane Models

- **Port of the Americas, Ponce, PR** - Crane Training System. Configured with a Ship-to-Shore Container Gantry Crane model and a Mobile-Jib Portal Harbour Crane model

- **Port of Marseille, France** - Crane Training System. Configured with 3 different Ship-to-Shore Container Gantry Crane models (Reggiane, Kone, and Paceco), a Jib-Boom Portal Crane model (Potain), and a Mobile-Jib Portal Harbour Crane model (Gottwald)

- **Shanghai Maritime University** – Advanced Dome System with Port Crane models including Ship-to-Shore Crane and RTG.
- **Port of Colombo, Sri Lanka** - Crane Training System. Configured with 2 different Ship-to-Shore Container Gantry Crane models, a Rubber Tyred Gantry Crane model, and a Rail Mounted Gantry Crane model

- **South African Port Operations** - Three (3) Crane Training Systems. Configured with a Ship-to-Shore Container Gantry Crane model and a Rubber Tyred Gantry Crane model. These systems were installed in standard 40’ ISO containers

- **Freeport Container Port, Grand Bahamas** - Crane Training System. Configured with a Ship-to-Shore Container Gantry Crane model and a Rubber Tyred Gantry Crane model. This system was installed in a standard 40’ ISO container

- **Northrop Grumman Shipbuilding (Avondale), New Orleans, Louisiana** - Crane Training System. Configured with a dual lift Clyde Portal Crane model. This system was installed in a standard 22' trailer

- **International Union of Operating Engineers (IUOE)** - Crane Training System (27 Systems Purchased). These systems are configured with a Mobile Lattice Crane model and a Hydraulic Telescopic Crane model. Each of these units was installed in a standard 22' trailer with an integrated power distribution system (land power or generator power)

- **Seafarers Harry Lundeberg School of Seamanship (Maryland, USA)** – Essential Plus crane simulator model with inverted "T" design. System features Liebherr Ship Pedestal Crane and Hagglund Ship Pedestal Crane.

- **US Army** - Crane Training System. This system is configured with a Ship Pedestal Crane model, Ship-to-Shore Container Gantry Crane model, and a Rough Terrain Hydraulic Telescopic Crane. 12 smaller additional units purchased configured with a Ship Pedestal Crane model and a Ship-to-Shore Container Gantry Crane model.

- **US Navy -** Crane Training System (10 Units Purchased). These systems are configured with a Ship Pedestal Crane model, Ship Container Gantry Crane model, and a Rough Terrain Container Handler model. Each of these units was installed in a standard 22' trailer with an integrated power distribution system (land power or generator power)